

Inouea, gen. nov., a new genus from the Philippines, with the type species *I. cyclobalia* (West, 1929), and two new species

(Insecta, Lepidoptera, Geometridae, Ennominae)

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The genus *Inouea* is described with the type species *I. cyclobalia* (West, 1929), comb. nov. from the Philippines. Diagnostic differences in habitus, male and female genitalia distinguish two further new species from the Philippines, *I. hiroschii*, spec. nov. and *I. colini*, spec. nov. The larvae and the host-plants remain unknown. Holotypes are deposited in the coll. Treadaway and will later on be transferred to the SNG.

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Introduction

The description of the first red-coloured *Abraxas* species (Stüning & Hausmann 2002, see above in this journal), was the starting point to study more in depth additional material of similar habitus. Some taxa that, superficially, were reminiscent of the newly described *Abraxas* species were found in the coll. C. G. Treadaway, Limbach. Detailed study, however, revealed, that these taxa belong to a group that is not closely related phylogenetically. It was furthermore quite surprising to determine, that '*Abraxas cyclobalia* West, until now regarded to be a true *Abraxas* species, belongs also to the species group, which is described below as the new genus *Inouea*.

Abbreviations and Conventions

- CGT: Private collection C. G. Treadaway, Limbach, Germany.
SNG: Senckenberg-Museum, Frankfurt am Main.
ZFMK: Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn.

Forewing length is measured as straight line between base and apex of wing. Most of the examined material is from coll. Colin G. Treadaway, Limbach, Germany. Types, unless stated otherwise, will be returned to this collection which, in due time, will become part of the SNG collection, Frankfurt a.M., Germany.



Fig. 1. Venation of *Inouea cyclobalia* West.

Systematic account

Inouea Stüning, gen. nov.

Type species: *Abraxas cyclobalia* West, 1929.

Diagnosis. Medium sized, reminiscent to *Abraxas*, ground colour whitish or reddish, with dark grey or black spots. ♂ antennae simple, broad dorso-ventrally, flat laterally, homogeneously ciliate-setose, with short, fine setae and one stout distal 'sensillum styloconicum' at each antennomer. ♀ antennae similar, flagellum more rounded in sectional view. Palpi prominent, distal segment very small. Proboscis stoutly developed. Spur formula of tibiae 0-2-4 (♂♀), hindtibia of ♂ dilated, with pencil. Venation (Fig. 1): R1 and R2 long stalked, R1 anastomosing with Sc, R2 connected to stalk of R3+R4 by short transversal branch. Common stalk of R3-R5 arising far from upper cell apex, approached to origin of R1+R2. Length of anastomosis of R1 and Sc varying individually and between species, terminal part of Sc sometimes lacking, the

transverse vein between R2 and R3+R4 sometimes also lacking. Origin of M2 closer to M1 than M3. Fovea absent.

Abdomen. Yellowish or reddish, with rows of black spots. Cavi tympani large, globular, without lacinia. Group of setae present on sternite A3, but weakly developed. Genital membrane loosely covered with hair-shaped scales.

♂ genitalia. Uncus stout, slightly curved ventrad, tapered at tip, bill-shaped from lateral view. Gnathos absent. Valva with strongly dilated costa, with stout bristles, distally tapering to 1-2 thorn-shaped processi. Costa with short stout setae over the whole length. Central part of valva (lamina) reduced to rounded lobe, covered at the outer part by modified, elongate, stout scales. Sacculus separate from valva, strongly sclerotized, with dorsal tooth. Aedeagus. Vesica everting dorsad, basally slightly dilated, with three large multiple toothed cornuti.

♀ genitalia. Bursa posteriorly stronger sclerotized, anteriorly membranous, with sclerotized transverse fold (signum). Ductus bursae reduced, colliculum directly connected to corpus bursae, ductus seminalis arising between. Colliculum posteriorly with long furcate ventral process, dorsally projecting in a rounded, worm-shaped, distally dorsad curved process. Dorsal process usually longer than ventral. Lamella antevaginalis membranous, voluminous, partially sclerotized. Lamella postvaginalis membranous, furrowed, densely covered with scales.

Distribution. All three known species endemic to Philippines.

Derivatio nominis. Dedicated to Prof. Dr. Hiroshi Inoue on his 85th birthday.

Inouea cyclobalia (West), comb. nov.

Figs 2-5, 11, 14, 15

Types: BMNH, London, 1♂, 1♀.

Type-locality: Philippine Is., Luzon Is., subprov. Benguet, Baguio, Trinidad, 4800 ft.

Examined Material: 6♂♂, 4♀♀, Philipp., N. Luzon, Ifugao, Mt. Polis, 1600-2000 m (colln ZFMK, CGT, Schaarschmidt/Phyllodrom); 2♀♀, W. Mindanao, Misamis occ., Jimenez, Mt. Malindang, 1000 m (CGT).

Diagnosis. Length of forewing ♂ 20-21 mm, ♀ 21-24 mm. West (1929) gives exact and detailed description of habitus. Compared with the females of the following species that are also coloured with black and white *I. cyclobalia* is characterised as follows: Wings more rounded, cell spots round, of equal size on both wings, dark terminal fascia distinctly interrupted in forewing, terminal spots of hindwing sickle-shaped, tergite A1 clear white. Both ♀ from Mindanao externally well matching habitus of specimens from Luzon.

Abdomen. ♀ with tergite A7 very large, twice size of sternite A7. Cavi tympani (♂♀) not globular.

♂ genitalia (Fig. 11). Costa of valva strongly dilated, with some setae, distally with two stout, thorn-shaped processi with some further small teeth at or between them. Tip of costa narrower and more tapering than in the other species. Lobus at central part of valva with brush of elongate, stout scales. Sacculus with sharp ventral longitudinal edge, apically projecting to tapered process. Dorsal tooth longer than in related species. Aedeagus comparatively short and thick, vesica with two very large and one smaller cornuti, with smaller teeth at their base.

♀ genitalia (Figs 14, 15). Corpus bursae subrectangulate, anteriorly tapered to a process on the left side. Posterior third slightly sclerotized, stiff, comparatively smooth. Anterior part membranous. Transverse folding dark brown sclerotized, close to dorsal process. Ductus bursae reduced or vestigial. Colliculum large, dark brown, with ventral process Y-shaped, dorsal process much longer. Lamella antevaginalis with two oblique, granulose, subventral patches. Lamella postvaginalis membranous, furrowed, densely covered by scales, distally with two lateral appendices. Ovipositor oval, elongate. Length of apophyses anteriores about once, of apophyses posteriores twice length of ovipositor. One ♀ examined from Mindanao with many genitalic differences (Fig. 15): Shape of corpus bursae different, tapering process arising medially, colliculum longer and narrower with ventral process of different shape, ovipositor more elongate and distally tapering, apophyses posteriores much longer. These considerable differences suggest the populations of Mindanao to be different at rank of subspecies or sister species, as they are geographically dis-

tant and, probably, well isolated from the populations of Luzon. More material, especially males, is needed to clarify their taxonomic status.

Biology and Bionomy. Immature stages unknown. Flight period: February, May, June, August, November.

Distribution. Philippines: Luzon, Mindanao (first record for the latter).

Inouea hiroshii Stüning, spec. nov.

Figs 6-8, 12, 16

Types. Holotype: ♂, Philippinen, W. Mindanao, Misamis occ., Jimenez, Mt. Malindang 800 m, 6.ii.1988, local collector (Coll. CGT, later transferred to SNG). – Paratypes. 2♀♀, type-locality, 800 m, 6.ii.12.ii.1988 (Coll. CGT, later transferred to SNG).

Description

Length of forewing ♂ 18 mm, ♀ 19-21 mm. Ground colour of ♂ deep orange red, markings black, with slight bluish tinge at oblique illumination. Forewing costa black, irregularly bordered towards wing area. Terminal area of forewing black, very broad, submarginal row of spots fused to marginal, with rest of ground colour interposed. Postmedial 'line' dissolved to large spot near inner margin, medial spot fused to terminal fascia and crescent-shaped curved costal spot both fused with terminal and costal fasciae. Cell spot of medium size, oval, with similar spot below cell and a third, smaller one near inner margin of wing basis. Hindwing with marginal and submarginal rows of spots less fused and larger areas of ground colour between. Postmedial 'line' dissolved to wedge-shaped costal spot, medial spot close to termen and elongate spot near inner margin. Cell spot absent on hindwing. Basis of hindwing black, one further small spot at 1/3 of anal margin. Underside similar to upperside. Antennae black, frons dark brown, with central, dorsoventral yellow streak, lower third yellow. Palpi dark brown, yellow at base. Thorax yellow with dark brown spots. Hindtibia dilated, dark grey, with light grey pencil. Abdomen yellow, with row of large black central spots on the tergites, getting larger posteriorly, last tergites almost completely black. Rows of black spots also laterally and ventrally.



Figs 2-4. *Inouea cyclobalia* (West), Luzon. 2-3. ♂, 4. ♀.

♀ with ground colour white, pattern similar to ♂, but cell spots larger, more rounded, present also on hindwing, forewing spot below cell larger, rounded, medial spot of postmedial line larger. Colouration of body and palpi similar to that of ♂, frons yellow with two lateral black spots. One examined ♀ with black markings reduced, thus terminal and subterminal rows of spots better separated.

Abdomen. Cavi tympani large, sub-globular, without lacinia. Sternite A3 with patch of about 15 weak setae. Apodemes between tergites A1 and A2 narrow, in ♀ curved, claw-shaped.



Fig. 5. *Inouea cyclobalia* (West), ♀, Mindanao.

♂ genitalia (Fig. 12). Costa of valva dilated, but less than in *I. cyclobalia*, outwardly curved, with many setae, distally with only one stout, thorn-shaped, inwardly curved process. Tip of costa stouter and more rounded than in *I. cyclobalia* narrower and more tapering than in the next species. Central part of valva less reduced, without lobus and with less modified scales. Sacculus tender and shorter, without ventral edge, apically rounded, dorsal tooth weaker. Aedeagus comparatively long and slender, vesica near ductus with projecting, distally dentate appendix. Two further rows of teeth at the base of (everted) vesica.

♀ genitalia (Fig. 16). Corpus bursae elongate. Sclerotized posterior part elongate oval, longitudinally furrowed. Anterior, membranous part sub-rectangulate, without tapered process. Transverse folding (signum) similar to that of *I. cyclobalia*, but in ventral position. Ductus bursae reduced. Colliculum not brown as in *I. cyclobalia*, much less sclerotized, with ventral process strongly dilated, dorsal process stout, but only slightly exceeding ventral process. Lamella antevaginalis membranous, with only one large, rounded, granulose, central patch. Lamella postvaginalis membranous, without furrows or appendices. Ovipositor oval. Length of apophyses posteriores three times length of ovipositor.

Biology and Bionomy. Immature stages unknown. Habitat. Primary forest at about 800 m above sea-level. Flight period: February.

Distribution. Philippines: western Mindanao.

Derivatio nominis. Dedicated to Prof. Hiroshi Inoue on his 85th birthday.



Figs 6-7. *Inouea hiroshii*, spec. nov., Holotype, ♂, upper side (6) and under side (7), Mindanao.

Inouea colini Stüning, spec. nov.

Figs 9-10, 13, 17

Types. Holotype; ♂, Philippinen, Negros or., Alabasi, Mt. Canla-on 1500 m, 6.xii.1976, local collector (Coll. CGT, later transferred to SNG). – Paratypes: 1♂, id., 4000 ft., 10.v.1976; 1♂, id., nr. Mambucal, 9.ix.1985; 2♂♂, id., 3.i.2000; 1♂, id., 20.vi.2001; 1♀, id., 11.vi.1995 (Coll. CGT, later transferred to SNG, 1♂ in coll. ZFMK).

Description

Length of forewing ♂ 18-20 mm, ♀ 21 mm. Ground colour of ♂ orange red, slightly lighter than in the preceding species. Markings black. Forewing costa black, irregularly bordered towards wing area, broader than in *I. hiroshii*. Terminal area of forewing black, very broad, extended all over distal half of wing and including also submarginal row of spots (rarely with scarce rest of ground colour visible between spots). Cell spot large, oval, usually fused



Fig. 8. *Inouea hiroshii*, spec. nov., Paratype, ♀, Mindanao.

to costa and terminal fascia. Spot below cell round, smaller than in *I. hiroshii*, at more distal position. Antemedial line reduced to oblique streak at the inner margin of the wing basis. Hindwing with broad terminal fascia, though



Fig. 9. *Inouea colini*, spec. nov., Paratype, ♂, Negros.



Fig. 10. *Inouea colini*, spec. nov., Paratype, ♀, Negros.

not including postmedial row of spots, the latter consisting of a broad costal spot and an elongate spot at anal margin. Small cell spot usually present. Additional spot small at about $\frac{1}{3}$ of anal margin, usually divided. Underside similar to upperside. Antennae black. Palpi and frons black or dark brown, the latter with orange transverse line of variable width. Parts of tegulae orange, rest of thorax and abdomen deep yellow with black spots, last segment and ventral side almost completely black. Legs black. Hind tibia dilated, with light grey pencil.

♀ much resembling that of *I. hiroshii*, slightly larger, rows of spots less fused. Forewing with distinct, large, sub-rectangular spot between M2 and CuA1. Cell spots slightly larger and rather oval, spots below cell smaller, irregularly shaped. Cell spots of hindwing comma-shaped, much smaller than those of *I. hiroshii*. Body light yellow, with black spots. Dorsal half of frons black, ventral deep yellow. Palpi dark grey, with some yellow scales between the first two segments. Tegulae deep yellow at base, distally black.

Abdomen. ♀ tergite A7 smaller than in *I. cyclobalia*, slightly larger than sternite A7. Cavi tympani very large, sub-globular, tympanum small.

♂ genitalia (Fig. 13). Very similar to those of *I. hiroshii*. Costa of valva dilated, but less than in *I. hiroshii*, only slightly curved outwardly, with many setae, distal thorn-shaped process shorter, less curved inwardly. Tip of costa still shorter, broader and more rounded than in *I. hiroshii*. Central part of valva less outwardly curved, near sacculus with strongly sclerotized longitudinal fold (absent in *I. hiroshii*), ventral part of costa angled at base. Sacculus exceeding even central part. Aedeagus slightly stouter, basal rows of teeth stouter, but shorter, terminal appendix shorter.

♀ genitalia (Fig. 17). Corpus bursae elongate. Posterior part curved, only weakly sclerotised, almost without longitudinal wrinkles. Anterior part rounded, membranous. Transverse folding (signum) similar to that of *I. hiroshii*, in ventral position close to tip of bursa. Ductus bursae reduced. Colliculum as in *I. hiroshii*. Ventral process of colliculum strongly dilated at base, roof-shaped angled, large and broad lateral parts at obliquely dorsad position, with roof-shaped longitudinal edge. Dorsal process stout, as long as ventral process.

Lamella antevaginalis as in *I. hiroshii*, but sclerotised medial patch narrower and distally tapering. Lamella postvaginalis membranous. Ovipositor stouter, longer, distally tapering, densely setose.

Biology and Bionomy. Immature stages unknown. Habitat. Primary mountain forest from 1300 to 1500 m above sea-level. Flight period: January, May, June, September, December, probably occurring in all months of the year.

Distribution. Philippines: Negros.

Derivatio nominis. Dedicated to Colin G. Treadaway, Limbach, for the kind loan of material and the donation of paratypes.

Discussion

Species of the new genus *Inouea* differ from – only superficially similar – species of *Abraxas* Leach (subgenus *Calospilos* Hübner) in such a large number of basal characters, that it is not possible to consider both being closely related, not even to place *Inouea* into the tribe Abraxini. Ample material for comparison has been provided by the work of H. Inoue himself who always focussed on Geometridae and within them on the genus *Abraxas* Leach. He has studied and revised, in the course of the last three decades, a major part of the East Asian species of this genus (see Inoue 1970, 1972, 1984, 1987, 1994, 1995) and described more than 30 species as new to science. However, the Indo-Malayan Archipelago has not so far been studied by him. Ample material of *Abraxas* of this region has been accumulated during the last decade in the collections of ZSM (Sumatra; coll. Herbulot: Sulawesi, Molukkas), coll. M. D. Sommerer, Munich (Sumatra), coll. C. G. Treadaway, Limbach (Philippines), coll. M. Schaarschmidt, Leipzig (Phyllostrom Soc.; N. Guinea, Philippines, Sulawesi), ZFMK (Philippines, Sulawesi, Molukkas etc.) and preliminary investigations have been carried out. As an initial result, the spectacular, red *Abraxas* (*Calospilos*) *breueri* Stüning & Hausmann has been described from Mindanao, Philippines. In the geographical region mentioned above species of the subgenus *Calospilos* Hübner occur exclusively, reaching N. Guinea with several and even Australia with one species.

A surprising phenomenon in this region is that a number of species – several of them being still undescribed – change from the usual coloration of *Calospilos* as known from mainland Asia (and Europe) to a mere black & white pattern, combined with a day-active habit (typical species: *A. (C.) triseriaria* Herrich-Schäffer, [1855]). Thus, they have obviously achieved becoming members of a successful mimicry-ring, together with other poisonous or distasteful species of different families (Arctiidae, Nyctemerinae; Zygaenidae, Chalcosiinae, genus *Corma* Walker). A number of non-poisonous, unprotected species are known to benefit from this situation by exhibiting surprisingly similar pattern and coloration. The black & white species of *Inouea* fit into this model, though it is unknown if they themselves are poisonous or if they are imitators. The occurrence of reddish males – also seen in *A. (C.) breueri*, but in both sexes – cannot be explained satisfactorily at present. This highly aposematic coloration may provide a better protection by itself, it even may be the base for a second mimicry-ring the species-composition of which being largely unknown to us (there is an undescribed species of *Ctimene* Boisduval from Mindanao in coll. CGT which is very similar externally and may also be a member of this mimicry-ring).

Another open question is, whether males and females of the two new species of *Inouea* are in fact conspecific – as considered in the present paper – or not. Similar pattern-arrangement, fitting size-ratios, the fact that there are no black & white males, though normally more abundant than females, and some details of body-pattern (e.g. the very similar coloration of the face and the palps in both sexes) are in favour of this opinion. Against it are that in *I. cyclobalia* definitely both sexes are of the same ground colour, that males are also missing for the two females of *cyclobalia* from W. Mindanao, that the female genitalia of *I. hiroshii* and *I. colini* are distinctly different while those of the males are quite similar. Moreover, the phenomenon of so strikingly different males and females is rather unusual for Geometrids. Additional material is needed to solve these questions, so the authors would like here to express their strong desire to have the opportunity to examine any such existing material.

The systematic position of *Inouea* is ques-

tionable, too. It does not belong to the Abraxini, as mentioned above, nor to the other tribes of Ennominae defined by Holloway [1994], except the Boarmiini. Therefore it is tentatively placed here. The Boarmiini, however, are probably a polyphyletic tribe and it will be up to future studies to elucidate the real relationship of the genera included.

Acknowledgements

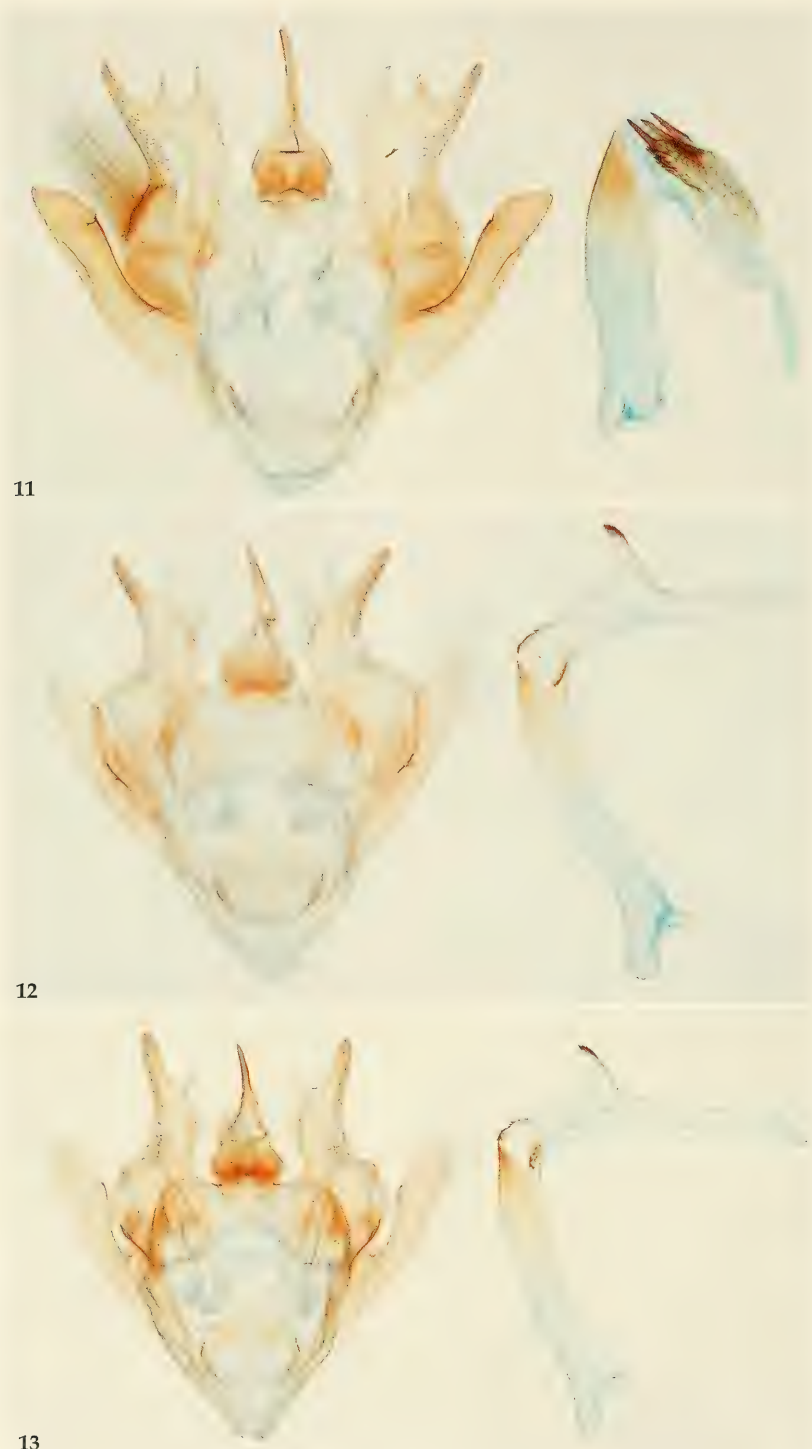
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Zusammenfassung

Die Gattung *Inouea* mit der Typusart *I. cyclobalia* West, 1929), comb. nov., von den Philippinen wird beschrieben. Auf der Basis deutlicher Differentialmerkmale in Habitus, ♂ und ♀ Genitalien werden zwei weitere Arten von den Philippinen, *I. hiroshii*, spec. nov. und *I. colini*, spec. nov. beschrieben. Larvalstände und Futterpflanzen dieser Arten sind unbekannt. Die Holotypen der neu beschriebenen Arten befinden sich in der Sammlung Treadaway und werden zu einem späteren Zeitpunkt an das SNG übergehen.

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Figs 11-13. ♂ genitalia of *Inouea* species. 11. *Inouea cyclobalia* West, Luzon. 12. *Inouea hiroshii*, spec. nov., Holotype, Mindanao. 13. *Inouea colini*, spec. nov., Paratype, Negros.



14



15



16



17

Figs 14-17. ♀ genitalia of *Inouea* species. **14.** *Inouea cyclobalia* West, Luzon. **15.** *Inouea cyclobalia* West, Mindanao. **16.** *Inouea hiroshii*, spec. nov., Paratype, Mindanao. **17.** *Inouea colini*, spec. nov., Paratype, Negros.

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